NeoBiota 89: 229–237 (2023)
doi: 10.3897/neobiota.89.110500
https://neobiota.pensoft.net

DISCUSSION PAPER

A peer-reviewed open-access journal
NeoBiota
Advancing research on alien species and biological invasions

Cortaderia selloana, an example of aggressive invaders that affect human health, yet to be included in binding international invasive catalogues

Diego Liendo[1], Juan Antonio Campos[1], Alberto Gandarillas[2,3]

1 *Department of Plant Biology and Ecology, University of the Basque Country (UPV/EHU), 48080 Bilbao, Spain* **2** *Institute for Research Marqués de Valdecilla, Ave. Herrera Oria SN, 39011 Santander, Spain* **3** *INSERM, Languedoc-Roussillon, 34394 Montpellier, France*

Corresponding authors: Diego Liendo (diego.liendo@ehu.eus); Alberto Gandarillas (agandarillas@idival.org)

Academic editor: Ingolf Kühn | Received 3 August 2023 | Accepted 23 October 2023 | Published 20 December 2023

Citation: Liendo D, Campos JA, Gandarillas A (2023) *Cortaderia selloana*, an example of aggressive invaders that affect human health, yet to be included in binding international invasive catalogues. NeoBiota 89: 229–237. https://doi.org/10.3897/neobiota.89.110500

Abstract

Invasive plant species can suppress local biodiversity, affect soil properties and modify the landscape. However, an additional concern of plant invasions that has been more disregarded is their impact on environmental human health. Here, we discuss the case of *Cortaderia selloana* (Schult. & Schult.f.) Asch. & Graebn, as an example of a worldwide invasive species with a strong environmental impact. We summarise the main facts regarding the *C. selloana* invasion, the recent clinical evidence of its impact on human health and the great potential expansion of the species in the context of climate change. *C. selloana* constitutes a clear example to boost demands from policy makers for urgent and efficient measures to control or eradicate invasive species, also in ruderal areas. This aggressive invader is still out of relevant binding international invasive species catalogues, including the European List of Invasive Alien Species of Union concern (Union list), and is still subjected to extensive trading in some European countries. Therefore, including *C. selloana* in the Union list becomes mandatory to impose full restrictions on keeping, importing, selling, breeding and cultivating the species.

Keywords

Alien plant, biological invasions, climate change, environmental health, pampas grass, respiratory allergy, Union list

Copyright *Diego Liendo et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

Biological invasions pose a substantial threat to ecosystems worldwide and constitute a critical driver of global change (Vilà et al. 2011). Invasive species are a global concern due to their negative ecological impacts, which include the loss of biodiversity at local and regional scales (Manchester and Bullock 2000; McGeoch et al. 2010; Vilà et al. 2011) or changes in community structure (Domènech et al. 2006; Hejda et al. 2009). In addition, invasions are associated with important economic and human-welfare impacts (Pimentel et al. 2000; Mazza et al. 2014; Hoffmann and Broadhurst 2016). For instance, the economic costs of invasive alien species in Europe have been estimated to total €116.61 billion between 1960 and 2020 (Haubrock et al. 2021). However, beyond the damage to ecosystems and the economy, we need to address the impacts of plant invasions on human health. Unlike invasive animals, the impacts of invasive plants on human health in Europe have been scarcely studied so far and only for a very small number of species, such as *Ambrosia artemisiifolia* or *Heracleum mantegazzianum* (Schindler et al. 2015; Bayliss et al. 2017). In this context, the grass *Cortaderia selloana*, commonly known as pampas grass, rapidly emerges as a species with a great ecological impact (Domènech et al. 2006) and with a clear potential impact on human health as a consequence of: (i) its striking current worldwide spread and (ii) the recently unveiled allergenic properties of the pollen (Rodríguez et al. 2021).

C. selloana and the morphologically close *C. jubata* have been traditionally regulated as distinct taxa. However, in a new synoptic taxonomy of the genus (Testoni and Linder 2017) the authors describe *C. selloana* and *C. jubata* as two subspecies within *C. selloana*. Although this could be of some relevance in terms of the potential inclusion of *C. selloana* in binding international invasive catalogues, we will here consider these taxa as distinct species following the previous nomenclature by Ascherson and Graebner (1900): *Cortaderia selloana* (Schult. & Schult.f.) Asch. & Graebn. [Syn. Mitteleur. Fl. [Ascherson & Graebner]. 2(1): 325].

Worldwide spread of *C. selloana*

C. selloana is native to South America and has naturalised in many regions across the globe, mainly Australia, New Zealand, South Africa, North America and Western Europe. In the latter, *C. selloana* has strongly colonised several countries such as Italy and the Atlantic coast including the UK, the Netherlands, Belgium, France, Spain and Portugal (Fig. 1) (Lambrinos 2001; Tarabon et al. 2018). In Europe, *C. selloana* is widely traded and used as ornamental species. This ornamental use includes fencing and protecting the garden or property due to its sharp leaves and decorating purposes with dried plumes. The expansion of *C. selloana* is strongly associated with human activity, as it colonises preferentially anthropogenic ruderal habitats of low environmental value, such as quarries, road margins, slopes, wastelands or industrial areas (Domènech and Vilà 2007; Pardo-Primoy and Fagúndez 2019). However, the species is also invading natural and semi-natural habitats of high environmental value, such as grasslands, wetlands, marshes and coastal dunes (Campos et al. 2004; Saura-Mas and Lloret 2005; Herrera et al. 2017) (Fig. 2).

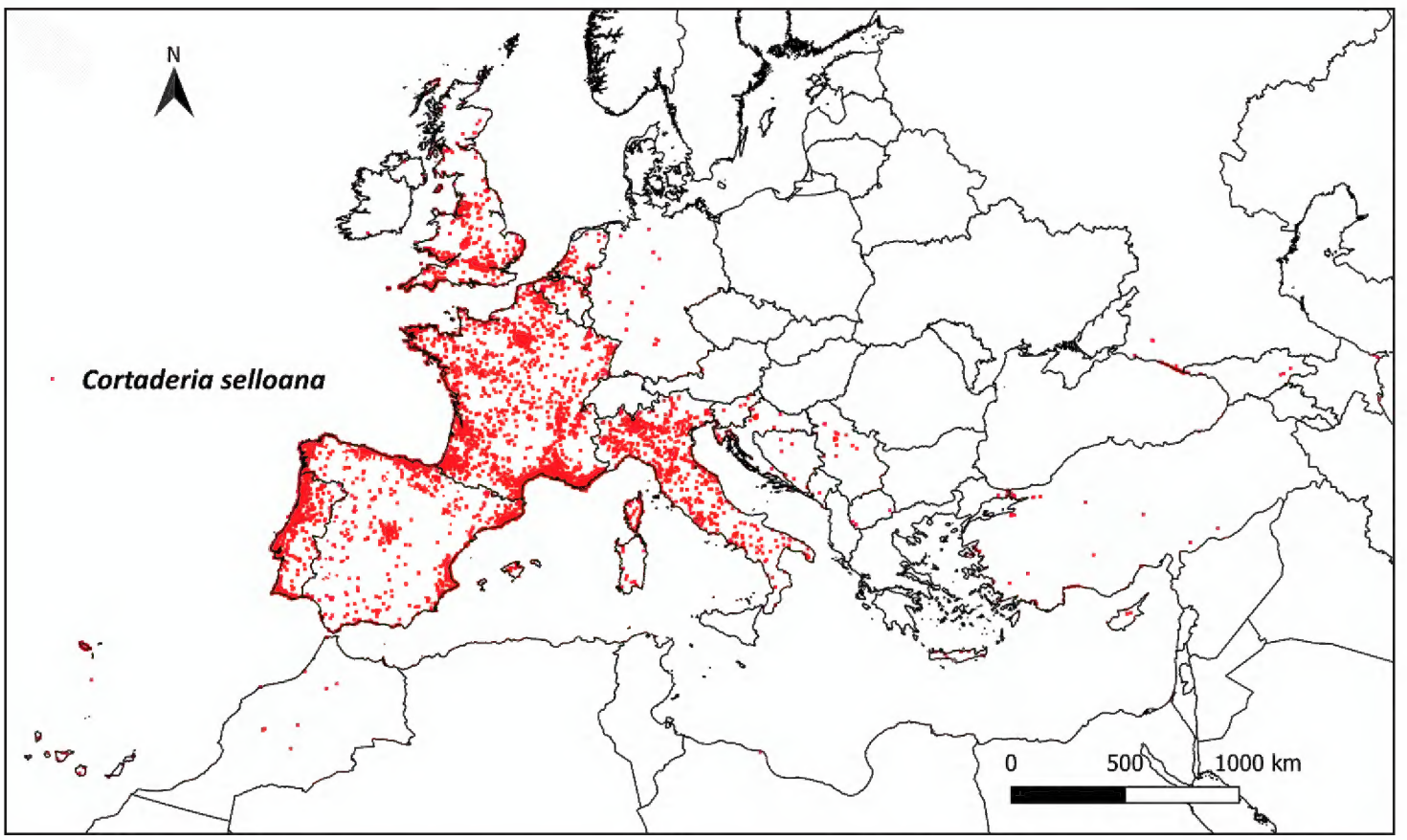

Figure 1. Current distribution of *Cortaderia selloana* (red squares) in Europe and nearby Mediterranean countries. Data retrieved from the Nature Database of Spain (available at: https://www.miteco.gob.es/es/biodiversidad/servicios/banco-datos-naturaleza/) and GBIF-Global Biodiversity Information Facility [GBIF.org (21 September 2022) GBIF Occurrence Download https://doi.org/10.15468/dl.fze4z8].

Impact of *C. selloana* on environmental health

Until recently, skin cuts due to the sharp leaves of *C. selloana* were the only impact associated to this species reported on human health (Mazza et al. 2014). However, grasses are a main source of human allergy (García-Mozo 2017). The potential allergenicity of the pollen of *C. selloana* had been suggested (Street et al. 1979; Başnou 2009; Pyšek and Richardson 2010; Kumar Rai and Singh 2020), but only recently has this allergenic potential been empirically confirmed in a human pilot study conducted in northern Spain (Cantabria; Rodríguez et al. 2021). This study concluded that the grass allergy season in Western Europe might be extended by several months. This first clinical study of the impact of *C. selloana* on human health emphasises that authorities of the international community should run larger clinical allergy tests, especially where it is highly invasive. While the allergenic capacity of *C. selloana* has only recently been demonstrated, a small bunch of other invasive plant species were already known to affect humans. These include giant hogweed (*Heracleum mantegazzianum*) and common ragweed (*Ambrosia artemisiifolia*) (Pyšek et al. 2007; Hemmer et al. 2011; Mazza et al. 2014; Montagnani et al. 2017). However, the potential impacts on human health of many other invasive plant species widely distributed in Europe are far less known. The estimations of the socioeconomic impact of the *C. selloana* invasion and other species should also be re-evaluated considering their impact on human health.

Figure 2. *Cortaderia selloana* can invade natural and anthropogenic habitats **A** Saltmarsh community in the Butrón estuary near Plentzia (Basque Country, Spain) **B** Saja-Besaya Natural Park in the municipality of Cieza (Cantabria, Spain) **C** urban area in Castro Urdiales (Cantabria, Spain) **D** abandoned quarry in Cuchía (Cantabria, Spain).

C. selloana and climate change

Under a scenario of increasing temperatures in the context of climate change, it is expected that plant species will experience spatial shifts in their distribution ranges (Parmesan and Yohe 2003; Rasmussen et al. 2017), reaching regions that currently are climatically unsuitable (Thuiller et al. 2005; Storkey et al. 2014; Rasmussen et al. 2017). This has been tested for some highly allergenic invasive alien plants present in Europe, such as common ragweed, which is predicted to expand its distribution range

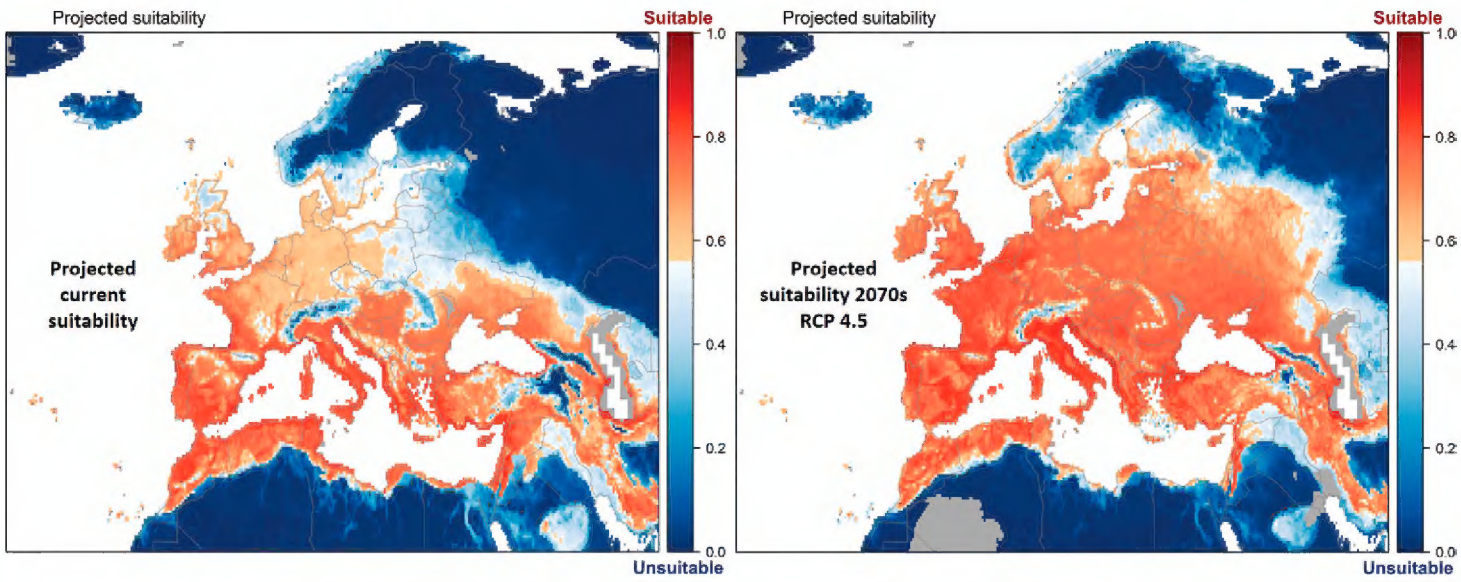

Figure 3. Maps of projected current and future suitability for *Cortaderia selloana* establishment in Europe and other countries of the Mediterranean region. Left: Projected current suitability. Right: Projected future suitability in the 2070s under Representative Concentration Pathways (RCP) 4.5, equivalent to a medium emissions scenario. Source: Brundu et al. (2021).

northwards and eastwards in the forthcoming decades as global temperatures continue to rise (Storkey et al. 2014; Lake et al. 2017; Rasmussen et al. 2017). A similar trend is to be expected with *C. selloana*. Tarabon et al. (2018) reported that while this species already occupies large areas along the western and Mediterranean French coasts, their models predicted an expansion northward and inland to the east under future climates. They define *C. selloana* as a 'climate warming winner.' This suggests that the species may colonise in the future other European regions that currently are climatically unsuitable as temperatures continue to rise, with a potential increase in human health impacts caused by its allergenic pollen.

In this sense, the European Union has recently made a good projection of current and future suitability for *C. selloana* establishment in the EU under current climate and under two scenarios of climate change with similar results (Fig. 3) (Brundu et al. 2021). When comparing the current presence of the species (Fig. 1) with the projected current suitability (Fig. 3), we can see that the southern Atlantic coast has a similar suitability to that of the Mediterranean Basin. Yet, while the presence of *C. selloana* is currently overwhelming on the Atlantic regions it is less abundant on the central-eastern Mediterranean regions (Fig. 1). This is likely due to an initial colonisation of the plant in Europe through Atlantic countries. This means that current conditions might be even better for *C. selloana* in the Mediterranean coasts, especially in humid soils, which predicts a strong invasion in these countries. Regarding the projected maps of suitability in the 2070s based on estimated future climate conditions under the Representative Concentration Pathways (RCP) 2.6 and 4.5, which represent low and medium emissions scenarios, respectively (Brundu et al. 2021), the whole of Europe and the Mediterranean region are expected to be highly suitable for the establishment of *C. selloana* under both scenarios (Fig. 3, RCP 4.5 scenario).

Need for an active EU strategy

In this context, some goverments have begun to take measures against the invasion by *C. selloana*. In some countries, such as the UK or Spain, where the grass is extensively established, it has been officially classified as an invasive species, with prohibition to import, plant, maintain or commercialise (Bayón and Vilà 2019). The species is also in the European and Mediterranean Plant Protection Organization (EPPO) list of invasive alien plants (https://www.eppo.int/ACTIVITIES/invasive_alien_plants/iap_lists). However, the European Union (EU) has not yet included *C. selloana* in the List of Invasive Alien Species of Union concern (the Union list; Regulation (EU) 1143/2014 and subsequent updates), despite having approved in recent years a €3.5 million LIFE project to tackle the invasion in the Western Atlantic coast from 2018 (LIFE Stop Cortaderia, http://stopcortaderia.org/), which has been recently granted another aid of €6.5 million starting in 2023 (LIFE22-GOV-ES-Coop Cortaderia). Other EU projects tackled restoration of natural areas, where *C. selloana* was one of the main invaders (Basic Search on LIFE Public Databases). Consequently, we encourage the European authorities to implement an EU level plan to tackle the invasion by *C. selloana*. Although some local plans are being implemented, a common EU plan would be instrumental. To serve this purpose, a first step should be its inclusion in the Union list, which involves restrictions on keeping, importing, selling, breeding and growing of those species included in the list. This is especially important given that numerous suppliers are listed throughout EU Member states and that both seeds and dried plumes can be easily purchased via online suppliers (Brundu et al. 2021).

The *C. selloana* invasion is not yet as prominent in the Central or Northern EU countries and this might pose some conflict of interest within the Union. However, in the latest risk study report, the European Commission has identified this species with high risk and pointed out that a ban on sale could act to prevent further spread of the species (Brundu et al. 2021). According to the same report, *C. selloana* might be worth more than €200 million every year in Europe as a result of 20–25 million plants being cultivated at European nurseries. Our request to include *C. selloana* in international binding lists is also in line with the conclusions of the IUCN World Conservation Congress held in 2021 in Marseille, France, which included a call on governments in the EU to propose the inclusion of this species in the Union list (https://www.iucncongress2020.org/motion/005). Finally, it can only be paradoxical that *Cortaderia jubata*, a morphologically close species of the same genus not widely present in the EU, was included in the Union list in the second update entered into force on 15 August 2019. If the ecological facts were not sufficiently convincing, the recent findings proving the allergenic capacity of the plant reinforce the urge to implement an EU common plan against the *C. selloana* invasion. Our further conclusive message is that invasive plant species must be fought not only because of their ecological impact, but also because of their impact on human health. This adds another level of concern that will require the involvement of health governmental authorities, agencies, and policy makers.

Acknowledgements

We thank Fernando Rodríguez and the members of the Stop Cortaderia Project (especially Santiago García, Blanca Serrano and Hélia Marchante) for discussions, as well as Marta Uranga for the photograph of *C. selloana* in the Saja-Besaya Natural Park of Cantabria. We are also grateful to Giuseppe Brundu for his helpful suggestions.

DL and JAC were funded by the Basque Government (IT1487-22). The authors have declared that no competing interests exist.

References

Ascherson P, Graebner P (1900) Synopsis der Mitteleuropäischen Flora, Vol. II, 1. Wilhelm Engelmann (Leipzig), 1–795.

Başnou C (2009) *Cortaderia selloana* (Schult. & Schult.) Asch & Graebn., pampas grass (Poaceae, Magnoliophyta). DAISIE: Handbook of alien species in Europe. Springer, Dordrecht, 346–346. https://doi.org/10.1007/978-1-4020-8280-1

Bayliss HR, Schindler F, Adam M, Essl F, Rabitsch W (2017) Evidence for changes in the occurrence, frequency or severity of human health impacts resulting from exposure to alien species in Europe: A systematic map. Environmental Evidence 6(1): 21. https://doi.org/10.1186/s13750-017-0100-4

Bayón A, Vilà M (2019) Horizon scanning to identify invasion risk of ornamental plants marketed in Spain. NeoBiota 52: 47–86. https://doi.org/10.3897/neobiota.52.38113

Brundu G, Tanner R, Shaw R, Beckmann B (2021) Risk assessment template developed under the "Study on Invasive Alien Species – Development of risk assessments to tackle priority species and enhance prevention". Contract No 07.0202/2019/812602/ETU/ENV.D.2. In: European Commission (Eds) [(2022)] Study on invasive alien species: development of risk assessments to tackle priority species and enhance prevention (final report and annexes). Publications Office of the European Union, Luxembourg. https://is.gd/QMGsZV

Campos JA, Herrera M, Biurrun I, Loidi J (2004) The role of alien plants in the natural coastal vegetation in central-northern Spain. Biodiversity and Conservation 13(12): 2275–2293. https://doi.org/10.1023/B:BIOC.0000047902.27442.92

Domènech R, Vilà M (2007) *Cortaderia selloana* invasion across a Mediterranean coastal strip. Acta Oecologica 32(3): 255–261. https://doi.org/10.1016/j.actao.2007.05.006

Domènech R, Vilà M, Gesti J, Serrasolses I (2006) Neighbourhood association of *Cortaderia selloana* invasion, soil properties and plant community structure in Mediterranean coastal grasslands. Acta Oecologica 29(2): 171–177. https://doi.org/10.1016/j.actao.2005.09.004

García-Mozo H (2017) Poaceae pollen as the leading aeroallergen worldwide. Allergy 72(12): 1849–1858. https://doi.org/10.1111/all.13210

GBIF-Global Biodiversity Information Facility (2022) GBIF.org GBIF Occurrence Download. [21 September 2022]

Haubrock PJ, Turbelin AJ, Cuthbert RN, Novoa A, Taylor N, Angulo E, Ballesteros-Mejia L, Bodey TW, Capinha C, Diagne C, Essl F, Golivets M, Kirichenko N, Kourantidou M,

Leroy B, Renault D, Verbrugge L, Courchamp F (2021) Economic costs of invasive alien species across Europe. NeoBiota 67: 153–190. https://doi.org/10.3897/neobiota.67.58196

Hejda M, Pyšek P, Jarošík V (2009) Impact of invasive plants on the species richness, diversity and composition of invaded communities. Journal of Ecology 97(3): 393–403. https://doi.org/10.1111/j.1365-2745.2009.01480.x

Hemmer W, Schauer U, Trinca A, Neumann C, Jarisch R (2011) Ragweed pollen allergy in Austria: A retrospective analysis of sensitization rates from 1997 to 2007. The Journal of Allergy and Clinical Immunology 127(2): AB170. https://doi.org/10.1016/j.jaci.2010.12.675

Herrera M, Campos JA, Dana ED (2017) Alien Plants and their Influence on Vegetation. In: Loidi J (Ed.) The Vegetation of the Iberian Peninsula. Plant and Vegetation, vol 13. Springer, Cham, 499–531. https://doi.org/10.1007/978-3-319-54867-8_11

Hoffmann BD, Broadhurst LM (2016) The economic cost of managing invasive species in Australia. NeoBiota 31: 1–18. https://doi.org/10.3897/neobiota.31.6960

Kumar Rai P, Singh JS (2020) Invasive alien plant species: Their impact on environment, ecosystem services and human health. Ecological Indicators 111: e106020. https://doi.org/10.1016/j.ecolind.2019.106020

Lake IR, Jones NR, Agnew M, Goodess CM, Giorgi F, Hamaoui-Laguel L, Semenov MA, Solomon F, Storkey J, Vautard R, Epstein MM (2017) Climate change and future pollen allergy in Europe. Environmental Health Perspectives 125(3): 385–391. https://doi.org/10.1289/EHP173

Lambrinos JG (2001) The expansion history of a sexual and asexual species of *Cortaderia* in California, USA. Journal of Ecology 89(1): 88–98. https://doi.org/10.1046/j.1365-2745.2001.00524.x

Manchester SJ, Bullock JM (2000) The impacts of non-native species on UK biodiversity and the effectiveness of control. Journal of Applied Ecology 37(5): 845–864. https://doi.org/10.1046/j.1365-2664.2000.00538.x

Mazza G, Tricarico E, Genovesi P, Gherardi F (2014) Biological invaders are threats to human health: An overview. Ethology Ecology and Evolution 26(2–3): 112–129. https://doi.org/10.1080/03949370.2013.863225

McGeoch MA, Butchart SHM, Spear D, Marais E, Kleynhans EJ, Symes A, Chanson J, Hoffmann M (2010) Global indicators of biological invasion: Species numbers, biodiversity impact and policy responses. Diversity & Distributions 16(1): 95–108. https://doi.org/10.1111/j.1472-4642.2009.00633.x

Montagnani C, Gentili R, Smith M, Guarino MF, Citterio S (2017) The worldwide spread, success, and impact of ragweed (*Ambrosia* spp.). Critical Reviews in Plant Sciences 36(3): 139–178. https://doi.org/10.1080/07352689.2017.1360112

Pardo-Primoy D, Fagúndez J (2019) Assessment of the distribution and recent spread of the invasive grass *Cortaderia selloana* in industrial sites in Galicia, NW Spain. Flora (Jena) 259: 151465. https://doi.org/10.1016/j.flora.2019.151465

Parmesan C, Yohe G (2003) A globally coherent fingerprint of climate change impacts across natural systems. Nature 421(6918): 37–42. https://doi.org/10.1038/nature01286

Pimentel D, Lach L, Zuniga R, Morrison D (2000) Environmental and economic costs of nonindigenous species in the United States. Bioscience 50(1): 53–65. https://doi.org/10.1641/0006-3568(2000)050[0053:EAECON]2.3.CO;2

Pyšek P, Richardson DM (2010) Invasive species, environmental change and management, and health. Annual Review of Environment and Resources 35(1): 25–55. https://doi.org/10.1146/annurev-environ-033009-095548

Pyšek P, Cock MJW, Nentwig W, Ravn HP [Eds] (2007) Ecology and management of giant hogweed (*Heracleum mantegazzianum*). CABI, Wallingford, 352 pp. https://doi.org/10.1079/9781845932060.0000

Rasmussen K, Thyrring J, Muscarella R, Borchsenius F (2017) Climate-change-induced range shifts of three allergenic ragweeds (*Ambrosia* L.) in Europe and their potential impact on human health. PeerJ 5: e3104. https://doi.org/10.7717/peerj.3104

Rodríguez F, Lombardero-Vega M, San Juan L, de las Vecillas L, Alonso S, Morchón E, Liendo D, Uranga M, Gandarillas A (2021) Allergenicity to worldwide invasive grass *Cortaderia selloana* as environmental risk to public health. Scientific Reports 11(1): 24426. https://doi.org/10.1038/s41598-021-03581-5

Saura-Mas S, Lloret F (2005) Wind effects on dispersal patterns of the invasive alien *Cortaderia selloana* in Mediterranean wetlands. Acta Oecologica 27(2): 129–133. https://doi.org/10.1016/j.actao.2004.12.001

Schindler S, Staska B, Adam M, Rabitsch W, Essl F (2015) Alien species and public health impacts in Europe: A literature review. NeoBiota 27: 1–23. https://doi.org/10.3897/neobiota.27.5007

Storkey J, Stratonovitch P, Chapman DS, Vidotto F, Semenov MA (2014) A process-based approach to predicting the effect of climate change on the distribution of an invasive allergenic plant in Europe. PLoS ONE 9(2): e88156. https://doi.org/10.1371/journal.pone.0088156

Street DH, Gorrin H, Wallace W, Hamburger RN (1979) Pampas grass pollen: New clinically significant allergen. The Journal of Allergy and Clinical Immunology 63(3): 192–193.

Tarabon S, Bertrand R, Lavoie C, Vigouroux T, Isselin-Nondedeu F (2018) The effects of climate warming and urbanised areas on the future distribution of *Cortaderia selloana*, pampas grass, in France. Weed Research 58(6): 413–423. https://doi.org/10.1111/wre.12330

Testoni D, Linder HP (2017) Synoptic taxonomy of *Cortaderia* Stapf (Danthonioideae, Poaceae). PhytoKeys 76: 39–69. https://doi.org/10.3897/phytokeys.76.10808

Thuiller W, Lavorel S, Araújo MB, Sykes MT, Prentice IC (2005) Climate change threats to plant diversity in Europe. Proceedings of the National Academy of Sciences of the United States of America 102(23): 8245–8250. https://doi.org/10.1073/pnas.0409902102

Vilà M, Espinar JL, Hejda M, Hulme PE, Jarošík V, Maron JL, Pergl J, Schaffner U, Sun Y, Pyšek P (2011) Ecological impacts of invasive alien plants: A meta-analysis of their effects on species, communities and ecosystems. Ecology Letters 14(7): 702–708. https://doi.org/10.1111/j.1461-0248.2011.01628.x